INTEGRALLY HOUSED TUBE INSERT

This application claims the benefit of U.S. provisional application number 60/434349 filed on 17 December 2002 incorporated herein by reference in its entirety.

Field of The Invention

The field of the invention is tube couplings.

Background of The Invention

Coupling lengths of tubing, particularly flexible tubing used to transport fluids, has been a challenge for many years. Various types of sleeves, and adhesives have been used as couplers with a modicum of success, however, such methods and devices more or less permanently coupled tubes and did not allow for decoupling. It became known to use clamps in order to provide an easy way to couple and decouple, but such clamps were prone to problems caused by insufficient seals and insufficient gripping capability.

Gripping problems were addressed in European Patent 0373272B1, which describes an inner sleeve having ridges around the outer surface of the sleeve in order to grip a tube inserted over the sleeve. U.S. Patent 3454290 to Tairraz (July 1969) teaches a two piece threaded coupling that uses a "ring" (a collet type device) inside the coupling to grip a tube. By using flexible arms on the ring, the degree of holding can be varied based on the outward force that is being applied to the tube. Basically, the harder the tube is being pulled from the coupling, the tighter the grip on the coupling. The teachings of U.S. Patent 4005882 to Guest (February 1977) expand on the use of a ring or collet by allowing the ring or collet to be used in a one piece coupling. The '882 patent provides a tapered cam surface on the inside of a coupling that allows the collet's grip to be substantially varied such that decoupling of a tube is possible without removing the collet or unthreading the coupling.

In the '882 patent Guest also teaches an o-ring as a means of sealing. The use of an o-ring is often preferred because other means of sealing are either more permanent (such as adhesives) or less effective (such as silicon tape). Despite the use of an o-ring to aid in fluidly sealing a point of coupling, leakage at least partially attributed to worn o-rings, insufficient placement of o-rings, and unstable fittings persisted.

Also in European Patent EP0373272B1, Guest discusses that the sleeve can be inserted into a bore and once inserted, the sleeve resists extraction from the bore by means of resilient fingers that hold the sleeve within the bore. Although this may have provided a somewhat more stable fitting in terms of reduction of movement, the reduction of movement was a detriment with regard to sealing during pressurization and depressurization. Thus, problems related to sealing were not sufficiently addressed and a need remained for releasable couplings having less susceptibility to leakage.

Summary of the Invention

The inventive subject is directed toward a tube coupling that has a tube insert which is integrally housed within a coupling body. The tube insert is partly comprised of an elongated stem encircled by a sealing o-ring that forms a seal with a tube inserted into the coupling body and over the tube insert.

Another aspect includes a retaining disc that prevents outward movement of the tube insert from the coupling body and a tube insert stop that prevents inward movement of the tube insert within the coupling body.

A tube insert may have a base that is formed by a tapered leading end and an orthogonal trailing end. The leading end facilitates inward passage of the entire base through the retaining disc and the trailing end prevents outward passage of the base through the retaining disc. The trailing end can form a shoulder that also functions as a tube stop.

Yet a further aspect includes a tube insert that has a freedom of movement within the coupling body – that is, movement between an annual tube insert and a retaining disc. Movement of the tube insert within the coupling body adds to the reliability of the seal created by the o-ring encircling the stem of the insert.

Various objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the invention, along with the accompanying drawings in which like numerals represent like components.

Brief Description of The Drawings

Fig. 1A is a cross-sectional view of a tube insert.

Fig. 1B is a cross section view of a tube insert having outwardly projecting fingers.

Fig. 2 is a cross-sectional view of a tube insert engaged with a tube, and integrally housed in a tube insert using a retaining disc.

Fig 3 is a cross-sectional view of a tube insert and coupling body molded as a single unit.

Detailed Description

Referring first to **Fig. 1A**, a tube insert 100 generally comprises an elongated stem 110 and a base 120. The elongated stem 110 is encircled by a first sealing o-ring 115.

A preferred tube insert is made of a substantially rigid thermoplastic such as PVC (polyvinyl chloride), however other materials may also be suitable including other plastics (e.g. polyethylene, polypropylene, polycarbonate, and so on) and non-plastics (*e.g.* rigid elastomers and so on). A material with substantial rigidity is preferred in order to facilitate a fluid seal that is substantially leak-free. A tube insert made from a relatively flexible material such (e.g. polyisoprene) may also suffice although the seal may not be as strong because of the give in the material.

Tube insert 100 has interior walls or surfaces 130 that form a throughway 140 through which fluids can travel. Because fluids will likely flow through the throughway 140, the interior walls 130 of the tube insert 100 are preferred to be substantially impermeable to fluids that have a temperature of less than 150° F. In less preferred embodiments, the walls are substantially impermeable to fluids having a temperature less than 200 ° F. It should be noted that a tube insert is typically made from a single piece of molded plastic and therefore the material that the insert is made of is soft at a certain temperature. Plastics have a certain temperature above which they are soft and pliable, and below which they are relatively more hard and brittle. This is called the glass transition temperature, or *Tg*. In order for a plastic stabilizer to remain substantially impermeable to fluid, it is necessary that the Tg of

the throughway (*i.e*. the insert interior walls) be higher than the highest temperature of the fluid traveling through the throughway.

Insert 100 has a shoulder 122 that is orthogonal to the outside wall 112 of the enlogated stem 110. A shoulder generally functions to prevent outward movement of a tube insert from a coupling body and also to prevent inward movement of a tube (*i.e.* as a tube stop). A shoulder can vary in its angular relationship to an elongated stem and therefore other embodiments may include angles of more or less than 90 degrees so long as the shoulder is effective in preventing outward movement of the insert. Prevention of outward movement from the coupling is discussed in more detail infra.

As defined herein, "inward" movement is movement toward the middle of a coupling body while "outward" movement is movement away from the middle of the coupling body. Inward movement of an insert may be facilitated by a tapered leading end, for example 124 of Fig. 1A. A preferred taper has an angle that creates alignment with a retaining disc through which an insert base passes. Passage of the insert base though the retaining disc will be discussed in more detail with reference to Fig. 2 below. It should be noted, however, that the angle of the taper may vary, the only requirement being that the insert base be able to pass through a retaining disc.

Sealing o-ring 115 is made of rubber or some other soft substantially fluid impermeable material (e.g neoprene, saniprene, etc...) that is suitable to form a fluid seal. Because o-rings can be contaminated by frequent insertion and removal of tubes, it is advantageous for an o-ring to be constructed of a material that resists contamination due to friction. A sealing o-ring can be fit over the stem, cemented to the stem, or be molded to the stem as part of a rubber transfer molding process in which components made of different materials may be molded together. A rubber transfer molding process generally comprises the following steps: sheets or slugs of rubber material are placed on a tray (known as the "pot") in the mold; the pot has a "gate" hole corresponding with the cavity for each part to be produced by the mold; the mold closes and a heated plunger plate presses down on the rubber in the pot, forcing it to melt through the gate of the cavities; the rubber cures in the cavity, forming the finished part; and the mold is opened, parts are removed and trimmed.

Fig. 2 depicts a coupling system 200 generally comprised of a tube 210 an insert 220, and a coupling body 230. Insert 220 is comprised of an elongated stem 222 encircled by sealing o-ring 226, and a stem base 224. Fig. 2 also depicts an annular insert stop 234, a second o-ring 240, a third o-ring 250, a retaining disc 260, and a collet 270.

The tube insert 220 is integrally housed within coupling body 230. The term "Integrally housed" means that the tube insert is sufficiently prevented from removal that some component of the coupling system would have to be broken or deformed in order to remove the insert. In this case, the tube insert 220 is prevented from removal by the retaining disc 260, although it is possible to remove the tube insert 220 by breaking the coupling body, deforming the disc, breaking the disc, or removing the disc. Therefore, a tube is integrally housed if its removal is sufficiently impeded. Not only does a retaining disc prevent removal of an insert, it functions to protect o-ring 250, particularly from damage that may be caused when a tube is being inserted. Integral housing may be accomplished by any means that prevents removal of the insert form the coupling body including molding as a single unit and using fingers that contact the inner wall of a coupling body. **Fig. 1B** embodies a use of fingers 126 as a means of integrally housing a tube insert.

Tube 210 has an inner diameter that closely approximates the outer diameter of the tube insert 220 such that the sealing o-ring 226 creates a substantially fluid impermeable seal between the tube 210 and the insert 220. The inner diameter of the tube, however, should be sufficiently large to enable the tube to be manually pushed over the insert. Tube 210 can be pushed over the insert up to the tube stop or shoulder 228, which is generally flat or blunt.

Insert 220 has a elongated stem 222 that has a wall approximately .25 cm. thick, the inside of the wall forming a throughway 232 for passage of liquids and other materials. The base of the insert 224 has a tapered leading end 229 that allows for passage thorough retaining disc 260. It should be understood that the tapered leading end not only provides a reduced diameter but also aids in alignment of the disc with the base 224. The retaining disc is relatively flexible such that it allows inward passage of the base to be readily accomplished, yet it is inflexible enough to prevent outward passage of the base through the disc. Retaining disc 260 is set in a groove (not shown) in the inner wall of the coupling body such that the retaining disc is relatively stationery and will not move within the coupling body. Outward

passage of the base through the retaining disc is prevented by the resistance between the shoulder portion of the base and the retaining disc. The shoulder portion of the base has a slightly larger outside diameter than the inside diameter of the retaining disc. The difference in the diameters between the disc and the shoulder portion of the base is enough to prevent outward movement.

Coupling body 230 is depicted in Fig. 2 as a bi-directional coupling. It is contemplated that many other types of couplings will be utilized including an elbow, a tee, and even a cap. Coupling body 230 has an insert stop 234 that is an annular ridge that prevents inward movement of the tube insert 220. In a preferred class of embodiments, a tube insert can move inside a coupling body up to 4 cm. Movement of the insert within the coupling body is also referred to as "freedom of movement" and means that the tube insert can move in both an inward and outward direction before encountering resistance from the insert stop or the retaining disc. The movement of the tube insert, especially during pressurization and depressurization, helps ensure that a fluid tight seal is maintained between the tube insert and the tube. Without such movement within the coupling, the tube would move relative to the insert compromising the seal between them.

A user of the coupling system 200 depicted in Fig. 2 only has to push tube 210 over insert 220. While it is preferred that such action creates an overlap of at least 1 cm., there may be more or less of an overlap, for example as little as .125 cm.

Focusing now on **Fig. 3**, a coupling system 300 depicts a tube insert 310 having an encircling o-ring 312, a coupling body 320, a second o-ring 330, and a washer 340. An important aspect of this class of embodiments is that the insert 310 is molded to the coupling body as a single unit.

A tube 340 is inserted into the coupling body 320 by fitting the tube over the insert 310 and sliding it along channel 350. Thus, insertion of the tube into the coupling body simultaneously joins the insert and the tube. Insertion of a tube is aided by a tapered lead 312 on the tube insert 310.

Collet 360 has resilient arms 365 that extend into the coupling body 320 and therein close on the tube 340 when engaged by a tapered cam 325. Tension on the tube is released

when the collet is pushed inward toward the middle of the coupling assembly. When pushed inward, the collet does not engage the cam and therefore does not grip the tube. Thus, the embodiments herein allow a tube to be readily removed from a coupling and pulled off of an insert.

Washer 340 is 1 mm thick, made of a hard plastic, and functions to protect o-ring 330 from damage caused by insertion and removal of the tube 340. Of course, the size of a washer and material with which it is made can vary, so long as the washer is able to at least partially protect the o-ring from damage. Without a washer protecting it, an o-ring could be significantly damaged each time a tube were inserted or removed. It is contemplated that this significant damage would eventually cause an o-ring to leak.

European patent EP0373272B1 depicts a sleeve that can be inserted into a bore, and once inserted, the sleeve resists extraction from the bore by using resilient fingers that hold the sleeve within the bore. The embodiment elucidated by Fig. 3 is distinguished from that depicted in the '272 patent by at least three elements – a tapered lead on the insert, an o-ring on the stem of the insert, and the single unit construction.

It should be appreciated that in another class of embodiments, a tube and an insert may be joined outside of the coupling body and subsequently integrally housed within the coupling body as an assembly, however, such is not the preferred embodiment.

Methods of fluidly sealing a tube in a coupling body generally comprise the steps of: integrally housing a tube insert in a coupling; providing a o-ring encircling the tube insert; and pushing the tube over the tube insert such that the first o-ring simultaneously bears on both an interior wall of the tube and an exterior wall of the insert.

The step of integrally housing can include a provision for a retaining disc to prevent removal of the tube insert. Alternatively, a molded tube insert/coupling body section can be provided in which case a retaining disc would not be necessary.

Additionally, methods of advertising are being claimed in which a tube insert is provided and instructions are given on how to integrally house the insert within a coupling. Such instructions typically will be a product insert or instructions found on a web site. For

example, a tube insert can be sold to a user and the user can be informed that the tube insert can be placed inside a coupling body and held there by using a retaining disc.

Thus, specific embodiments and applications of an integrally housed tube insert have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims. Moreover, in interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.